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Arrowleaf balsamroot

Yellowstone's vegetation is composed primarily of typical Rocky Mountain species. It is also influenced by flora of the Great Plains to the east and the Intermountain to the west. The exact plant community present in any area of the park reflects a complex interaction between many factors including the regional flora, the climate, the topography, and the local substrates/soils.

The vegetation of the park is interrelated with the geology of the park (*see Chapter 2*). The region's caldera explosions catastrophically destroyed vegetation. In addition, glaciers significantly altered the region during the ice ages. Today, the roughly 1100 native species of flowering plants in the park represent the species able to either persist in the area or recolonize after glaciers, lava flows, and other major disturbances. Unlike southwestern Wyoming or central Idaho, the Greater Yellowstone region has few endemic vascular plant species, primarily in the eastern portion of the Absaroka Mountains outside of Yellowstone. Within Yellowstone, only two endemics occur, Yellowstone sand verbenas (*Abronia ammophila*) and Ross' bentgrass (*Agrostis rossiae*).

Major Types

Montane Forests

Yellowstone is clothed in forests, covering roughly 80 percent of the park. Miles and miles of lodgepole pine forest characterize the park, especially within the Yellowstone Caldera. Also present in the park are extensive areas of forest dominated by subalpine

Vegetation Overview

- Vegetation in Yellowstone is typical of the Rocky Mountains.
- Elements of the Great Plains and Great Basin floras mix with Rocky Mountain vegetation in the vicinity of Gardiner and Stephen's Creek.
- The interaction of climate and geologic substrate controls distribution of vegetation in the park.
- Disturbances—fire, floods, insects, disease—occur periodically, affecting portions of the park.
- Hydrothermal areas support unique plant communities and rare species.
- Lodgepole pine alone comprises 80% of the forest canopy.
- Six other conifer tree species: white-bark pine, Engelmann spruce, subalpine fir, Douglas-fir, Rocky Mountain juniper, limber pine.

- Deciduous trees include quaking aspen and cottonwood.
- Shrubs include common juniper, sagebrush (many species), Rocky Mountain maple.
- Wildflowers number in the hundreds.
- Two endemics—Ross' bentgrass and Yellowstone sand verbenas.
- More than 200 exotics, including Timothy grass and Dalmatian toadflax.

Management

- Controlling exotics, which threaten native species, that are prevalent in developed areas; some are spreading into the backcountry.
- Surveying areas for sensitive or rare vegetation before disturbance such as constructing a new facility.

fir and Engelmann spruce, especially in areas such as the Absaroka Range that are underlain by andesites. These species can also be common in the understory where the canopy is entirely composed of lodgepole pine. Through time, in the absence of fire, the subalpine fir and Engelmann spruce will replace the lodgepole pine, leading to a canopy dominated by these species. At higher elevations such as the Absaroka Mountains and the Washburn Range, whitebark pine becomes a significant component of the forest. In the upper subalpine zone, whitebark pine, Engelmann spruce, and subalpine fir often grow in small areas separated by subalpine meadows. Severe conditions near treeline—wind and desiccation—cause distorted forms known as krumholtz where most of the 'tree' is protected below the winter snow.

Douglas-fir Forests

Douglas-fir forests occur at lower elevations, especially in the northern portion of the park. The thick bark of Douglas-fir trees allows them to tolerate low-intensity fire. Some of

Major Vegetation Types

Wildflowers

Wildflowers such as lupine and arnica often grow under the forest canopy, but the most conspicuous wildflower displays occur in the open meadows and sagebrush-steppe. The appearance of spring beauties, glacier lilies, and steer's head announce spring in the park. Soon colors splash the slopes, especially on the northern range—yellow from arrowleaf balsam-root, white from phlox, reds and oranges from paintbrush, and blue from penstemon and lupine. Goldenrod and gentians indicate the coming of autumn.

the trees in these forests are several hundred years old and show fire scars from a succession of low intensity ground fires. In contrast, lodgepole pine trees have very thin bark and can be killed by ground fires

Understory Vegetation

The understory vegetation differs according to precipitation regime, the forest type, and the substrate. Lodgepole pine forest is often characterized by a very sparse understory composed mostly of elk sedge (*Carex geyeri*), or grouse whortleberry (*Vaccinium scoparium*). Pinegrass (*Calamagrostis rubescens*) occurs frequently under Douglas-fir forest but is also common under other forest types, especially where the soil is better developed or moister. In some areas of the park such as Bechler and around the edges of the northern range, a more obviously developed shrub layer is composed of species such as Utah honeysuckle (*Lonicera utahensis*), snowberry (*Symphoricarpos spp.*) and buffaloberry (*Shepherdia canadensis*).

Sagebrush-Steppe

The northern range is composed of extensive stretches of sagebrush-steppe. Mountain big sagebrush (*Artemisia tridentata var. vaseyana*) dominates this community type, along with several other species and varieties of sagebrush. Several grass species, such as Idaho fescue (*Festuca idahoensis*), also dominate sagebrush-steppe. The northern range can be spectacular with wildflowers in late June and early July. Sagebrush-steppe also occurs in Hayden Valley, Pelican Valley, and Gardner's Hole.

Wetlands and Riparian Areas

Even though the park is dominated by forest and sagebrush-steppe, many other community types occur here. Wetlands are a conspicuous component in the area, with extensive areas of sedge bottoms and willow thickets. Subalpine meadows are rich in the number of different species of wildflowers and merge into alpine tundra on the highest peaks. Rivers, lakes, and ponds support aquatic vegetation in addition to the obvious inhabitants such as fish.

Hydrothermal Communities

Yellowstone is the best place in the world to see hydrothermal phenomenon such as geysers and hot springs. Fascinating and unique plant communities have developed in the expanses of thermally heated ground. Many of the species that occur in the geyser basins are actually species that tolerate tremendously different conditions, and thus grow all over the western United States. Other species, though, are typical of the central Rockies, or are regional endemics.

Vegetation Map (next page)

Lodgepole pine forests

- Dominates more than 80% of the total park forested area.
- Can be seral (developing) or climax.
- Climax forests underlain by rhyolite.

Douglas-fir forests

- Lower elevations (<7600 ft.) associated with the Lamar, Yellowstone, and Madison river drainages.
- Often less than 20 inches of annual precipitation.
- More frequent historic fire interval (25–60 year) than other forest types in the park.

Spruce-fir forests

- Engelmann spruce and subalpine fir dominate older forests.
- Usually found on moist and/or fertile substrates.
- Climax forests underlain by andesitic soils.

Whitebark pine forests

- Major overstory component at elevations above 8400 feet.
- Major understory component of lodgepole-dominated forests from 7,000 to 8,400 ft in elevation.
- Seeds are ecologically important food for a variety of wildlife species.

Non-forest

- Includes grasslands, sagebrush, alpine meadows, talus, and hydrothermal environments.
- Encompasses the moisture spectrum from dry sagebrush shrublands to wet alpine meadows.
- Provides the winter and summer forage base for ungulates.

Other types not shown on map

- Aspen—found in small clones interspersed among the sagebrush/forest ecotone (transition zone) along the Yellowstone, Madison, and Snake river drainages.
- Wetland—includes various grass, forb, rush, and sedge species.
- Riparian—typically streamside vegetation includes cottonwoods, willows, and various deciduous shrubs.

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Map legend on p. 64

Effects of Disturbances

The park's vegetation appears at first glance to be static and unchanging, but must, in fact, respond to change. Hydrothermal plant communities demonstrate in very short periods of time that change is fundamental in any natural system. In a few days, the ground can heat up, perhaps triggered by an earthquake, and fry plants, while an adjacent area may be

turning cooler, allowing plants to invade a previously inhospitable place. The vegetation of the park today reflects the effects of many different types of natural disturbance such as forest fire (*see Chapter 6*), floods, landslides, insect infestations, blowdowns, and the continually changing climate.

Major Types of Trees**Lodgepole pine** *Pinus contorta*

- Most common tree in park
- Needles in groups of twos
- May have serotinous cones
- Up to 75 feet tall

Limber pine *P. flexilis*

- Needles in groups of five
- Young branches are flexible
- Up to 75 feet tall
- Often on calcium-rich soil

Whitebark pine *P. albicaulis*

- Grows at higher elevations, above 7000 feet
- Needles in groups of five
- Purple-brown cones produce important food for squirrels, bears, Clark's nutcrackers
- Up to 75 feet tall

Engelmann spruce *Picea engelmannii*

- Often along creeks, or wet areas
- Sharp, square needles grow singly
- Cones hang down and remain intact, with no bract between scales
- Up to 100 feet tall

Subalpine fir *Abies lasiocarpa*

- Only true fir in the park
- Blunt, flat needles
- Cones grow upright, disintegrate on tree
- Up to 100 feet tall

Douglas-fir *Pseudotsuga menziesii*

- Resembles the fir and the hemlock, hence its generic name *Pseudotsuga*, which means "false hemlock"
- Cones hang down and remain intact, with 3-pronged bract between scales
- Thick bark resists fires
- Up to 100 feet tall

Rocky Mountain juniper*Juniperus scopulorum*

- Needles scale-like
- Cones are small and fleshy
- Up to 30 feet tall

Cottonwood *Populus spp.*

- Several species and hybrids
- Up to 75 feet tall
- Thick, furrowed bark
- Seeds with tangled hairs—the "cotton"—dispersed by wind

Quaking aspen *Populus tremuloides*

- Sedimentary soils in damp areas
- Flexible stems quake and shiver in the breeze
- Trunks often rough and black due to browsing by elk and other animals
- Reproduces by cloning (most often), and by seeds (related to fire)

LOGEPOLE PINE

The lodgepole pine (*Pinus contorta*) is by far the most common tree in Yellowstone. Early botanical explorers first encountered the species along the West Coast where it is often contorted into a twisted tree by the wind, and thus named it *Pinus contorta* var. *contorta*. The Rocky Mountain variety, which grows very straight, is *Pinus contorta* var. *latifolia*. Various Native American tribes used this tree to make the frames of their tipis or lodges, hence the name "lodgepole" pine. Typically, lodgepole pine in Yellowstone is seldom more than 75 feet tall. The species is shade intolerant; any branches left in the shade below the canopy will wither and fall off the tree. Lodgepoles growing by themselves will often have branches all the way to the base of the trunk because sunlight can reach the whole tree.

Lodgepoles are the only pine in Yellowstone whose needles grow in groups of two. The bark is typically somewhat brown to yellowish, but a grayish-black fungus often grows on the shady parts of the bark, giving the tree a dark cast.

Like all conifers, lodgepole pines have both male and female cones. The male cones produce huge quantities of yellow pollen in June and July. This yellow pollen is often seen in pools of rainwater around the park or at the edges of lakes and ponds. The lodgepole's female cone takes two years to mature. In the first summer, the cones look like tiny, ruby-red miniature cones out near the end of the branches. The next year, after fertilization, the cone starts rapidly growing and soon becomes a conspicuous green. The female

cones either open at maturity releasing the seeds, or remain closed—a condition called serotiny—until subjected to high heat such as a forest fire. These cones remain closed and hanging on the tree for years until the right conditions allow them to open. Within a short period of time after the tree flashes into flame, the cones open up and release seeds over the blackened area, effectively dispersing seeds after forest fires. Trees without serotinous cones (like Engelmann spruce, subalpine fir, and Douglas-fir) must rely on wind, animals, or other agents to carry seeds into recently burned areas.

Lodgepole pines prefer a slightly acid soil, and will grow quickly in mineral soils disturbed by fire or by humans (such as a road cut). Their roots spread out sideways and do not extend deeply—an advantage in Yellowstone where the topsoil is only about 6 to 12 inches deep, but a disadvantage in high winds. Lodgepole pines are vulnerable in windstorms, especially individuals that are isolated or in the open.

Besides reseeding effectively after disturbance, lodgepole pines can grow in conditions ranging from very wet ground to very poor soil prevalent within the Yellowstone Caldera. This flexibility allows the species to occur in habitat that otherwise would not be forested.

Because lodgepole pines are dependent on sunny situations for seedling establishment and survival, the trees do not reproduce well until the canopy opens up significantly. In the Yellowstone region, this allows the lodgepole pine forest to be replaced by shade-loving seedlings of subalpine fir and Engelmann spruce where the soil is well-developed enough to support either of these species. In areas of nutrient poor soil, where Engelmann spruce and subalpine fir struggle, lodgepole pines will eventually be replaced by more lodgepole pine trees as the forest finally opens enough to allow young lodgepoles to become established.

Only Here

- Yellowstone is home to two endemic species—plants that grow nowhere else—Ross's bentgrass and Yellowstone sand verbenas.
- Endemics occur in unusual or specialized habitats such as hydrothermal areas.
- Several other unusual species in Greater Yellowstone Area: warm springs spike rush, which grows in warm water; and Tweedy's rush, sometimes the only vascular plant growing in acidic hydrothermal areas.

Ross's bentgrass (*Agrostis rossiae*)

Ross's bentgrass only occurs on thermal ground along the Firehole River and near Shoshone Lake. This species seems to require locations providing the right combination of moisture and warmth that create a natural greenhouse. The temperature within an inch of the surface under a patch of this grass is usually roughly 100°F. As a result, this grass is one of the first species to green up in warm nooks and crannies of geyserite—sometimes as early as January. Inflorescences (flowers) may be present in February and March, but typically the plants do not produce viable seed that early. Full bloom occurs in late May and early June. As soon as temperatures rise in the early summer, the plants dry out due to the summer sun above and the thermal heat beneath. Ross's bentgrass is already dead and hard to find by July when most of the park's wildflowers are in full bloom.

Closely related species of grass also occur in the geyser basins. Hot springs tickle grass (*formerly A. scabra*) is common all through the interior of the park. This species is much more frequently encountered in the geyser basins than Ross's bentgrass and is similar. Ross's bentgrass is shorter, rarely growing taller than six inches and more typically only 2–3 inches. Another diagnostic characteristic of Ross's bentgrass is that the inflorescence never completely opens up.

Any plant growing in thermal areas must be able to deal with constant change. A successful plant in the geyser basins must be able to shift location relatively easily as one major thermal change or several changes could

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Yellowstone sand verbenas

eradicate the entire population. Apparently, Ross's bentgrass deals with this problem efficiently. Its seed dispersal mechanism has not been studied, but probably includes traveling on the muddy hooves of bison and elk who inhabit thermal areas during the winter. Exotic species pose the only known threat; as they spread in thermal areas, they eventually may outcompete Ross's bentgrass.

Yellowstone Sand Verbena (*Abronia ammophila*)

Yellowstone sand verbenas occurs along the shore of Yellowstone Lake. Taxonomists debate the relationship of this population of sand verbenas to other sand verbenas. Recent work suggests that Yellowstone sand verbenas is distinct at least at the subspecific level, and is certainly reproductively isolated from the closest sand verbenas populations in the Bighorn Basin of Wyoming.

Sand verbenas are a member of the four o'clock family, which is primarily a tropical family of flowering plants. Very few members of the family grow this far north. Little is known about the life history of Yellowstone sand verbenas. It was described as an annual in the only monograph that has examined this genus in recent years, but it is a perennial. It grows close to the sand surface. Some individuals occur near warm ground, so the thermal activity in Yellowstone may be helping the survival of this species. The flowers are white and the foliage is sticky. Apparently, the sand verbenas flowers from roughly mid-June until killing frosts in early September.

The full extent and impact of exotic plants in Yellowstone is unknown. Many grow in disturbed areas such as developments, road corridors, and thermal basins; they also are spreading into the backcountry. Several exotics, such as the common dandelion, have spread throughout the park.

Exotic plants can displace native plant species and change the nature of vegetation communities. These changes can profoundly effect the entire ecosystem. For example, exotics unpalatable to wildlife may replace preferred native plants, leading to changes in grazing activity. In turn, this stresses plants not adapted to grazing.

Controlling all the exotic species, some well-established, is unrealistic. The park focuses control action on species posing the most

Exotic Species

- More than 200 exotic plant species in park.
- Resource managers target the most threatening species for control or removal.
- Species include:
Dalmation toadflax
Spotted knapweed
Canada thistle
Ox-eye daisy
Houndstongue
Leafy spurge

serious threat or those most likely to be controlled.

The park uses Integrated Pest Management—chemical, biological, sociological, and mechanical methods—to control some of the exotic plants. The park also cooperates with adjacent state and county Weed Control Boards to share knowledge and technology related to exotic plant detection and control.

Dalmation toadflax *Linaria dalmatica*

- Northern portions of the park, especially around Mammoth.
- Highly invasive, replacing native plants.
- Intense biological and chemical control efforts during the late 1960s and early 1970s were unsuccessful.

Spotted knapweed *Centaurea maculosa*

- Along roadsides and in the vicinity of Mammoth.
- Aggressive species that, once established, forms a monoculture, which could displace native grasses on the ungulate winter and summer ranges.
- Aggressive control efforts underway to prevent a catastrophic change in park vegetation.

Canada thistle *Cirsium arvense*

- Throughout the park and adjacent national forests.
- Airborne seed enable it to spread widely throughout the park, invading wetlands.
- Forms dense monocultures, thus radically changing vegetation.

Ox-eye daisy *Leucanthemum vulgare*

- Mammoth and Madison areas, where it may have been planted in flower gardens.
- Can become dominant in meadows, is unpalatable to elk and other wildlife.

- Control efforts have substantially curtailed infestation; monitoring and evaluation continue.

Houndstongue *Cynoglossum officinale*

- Primarily Mammoth and East Entrance.
- May have been introduced by contaminated hay used by both the National Park Service and concessioners in their horse operations.
- Highly invasive, replacing native plants.
- Seeds easily attach to the coats of animals, and thus spread along animal corridors.

Leafy spurge *Euphorbia esula*

- Small patches in Bechler and along roadsides, so far being successfully controlled but spreading actively in Paradise Valley north of the park and outside Bechler on the Targhee National Forest.
- Becomes a monoculture, forcing out native vegetation.
- Extremely hard to control because of deep roots (up to 30 feet) and dense vegetation.

For More Information

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Additional Information from Yellowstone National Park

- Yellowstone National Park website, www.nps.gov/yell, includes an array of park information about resources, science, recreation, and issues.
- Yellowstone Science*, published quarterly, reports on research and includes articles on natural and cultural resources. Free; available from the Yellowstone Center for Resources, in the Yellowstone Research Library, or online at www.nps.gov/yell.
- Yellowstone Today*, published seasonally and distributed at entrance gates and visitor centers, includes features on park resources such as hydrothermal features.
- Site Bulletins, published as needed, provide more detailed information on park topics such as bison management, lake trout, grizzly bears, and wolves. Free; available upon request from visitor centers.